

1 We claim:

- 1 1. A method to move an accessor within a data storage and retrieval system,
2 comprising the steps of:
3 providing an accessor comprising a velocity control program, wherein said
4 accessor is capable of traveling at a velocity V_{MAX} and accelerating at a maximum
5 acceleration a_{MAX} ;
6 receiving a request to move said accessor a distance from a first location to a
7 second location;
8 forming a first velocity profile wherein said accessor travels said distance in the
9 minimum time interval, and wherein said first velocity profile requires a first maximum
10 acceleration change;
11 calculating a second velocity profile, wherein said second velocity profile
12 includes a second maximum acceleration change, wherein said second maximum
13 acceleration change is less than said first maximum acceleration change;
14 determining if said accessor reaches a_{MAX} using said second velocity profile;
15 operative if said accessor does not reach a_{MAX} using said second velocity profile,
16 loading said first velocity profile into said velocity control program;
17 operative if said accessor does reach a_{MAX} using said second velocity profile,
18 loading said second velocity profile into said velocity control program;
19 moving said accessor using said velocity control program.
- 1 2. The method of claim 1, further comprising the steps of:

2 calculating a plurality of first velocity datapoints $v_{(i)}$ based upon said distance,
3 said V_{MAX} , and said a_{MAX} , wherein said first velocity profile comprises said plurality of
4 first velocity datapoints;
5 averaging two or more of said first velocity datapoints $v_{(i)}$ to form each of a
6 plurality of first averaged velocity datapoints $v_{(i)avg}$;
7 forming said second velocity profile using said plurality of first averaged velocity
8 datapoints $v_{(i)avg}$.

1 3. The method of claim 2, further comprising the step of calculating each of
2 said plurality of first averaged velocity datapoints $v_{(i)avg}$ using the equation:

$$3 \quad V_{(i)avg} = (1/(2N+1))(V_{(i-N)} + V_{(i-(N-1))} \dots + V_{(i)} \dots + V_{(i+(N-1))} + V_{(i+N)}),$$

4 wherein N is greater than or equal to 1.

1 4. The method of claim 2, further comprising the step of calculating each of
2 said plurality of averaged velocity datapoints $v_{(i)avg}$ using the equation:

$$3 \quad V_{(i)avg} = (1/(2N+1))(V_{(i-2N)} + V_{(i-(2N-1))} + V_{(i-(2N-2))} \dots + V_{(i)}),$$

4 wherein N is greater than or equal to 1.

1 5. The method of claim 1, further comprising the steps of:
2 forming a first acceleration profile using said first velocity profile;
3 calculating said second velocity profile by passing said first acceleration profile
4 through a low pass Butterworth filter having a cutoff frequency greater than or equal to
5 15 hertz.

1 6. The method of claim 1, further comprising the steps of:
2 receiving a request to transport an object;

3 setting a threshold moment arm for said accessor;
4 calculating an actual moment arm for said accessor carrying said object;
5 determining if said actual moment arm exceeds said threshold moment arm;
6 operative if said actual moment arm exceeds said threshold moment arm,
7 calculating a third velocity profile, wherein said third velocity profile includes a third
8 maximum acceleration change, wherein said third maximum acceleration change is less
9 than said second maximum acceleration change.

1 7. The method of claim 6, further comprising the steps of:
2 calculating a plurality of first velocity datapoints $v_{(i)}$ based upon said distance,
3 said V_{MAX} , and said a_{MAX} , wherein said first velocity profile comprises said plurality of
4 first velocity datapoints;
5 averaging three or more of said first velocity datapoints $v_{(i)}$ to form each of a
6 plurality of second averaged velocity datapoints $v_{(i)avg}$;
7 forming said third velocity profile using said plurality of second averaged velocity
8 datapoints $v_{(i)avg}$.

1 8. The method of claim 7, further comprising the step of calculating each of
2 said plurality of second averaged velocity datapoints $v_{(i)avg}$ using the equation:

3
$$V_{(i)avg} = (1/(2N+1))(V_{(i-N)} + V_{(i-(N-1))} \dots + V_{(i)} \dots + V_{(i+(N-1))} + V_{(i+N)}),$$

4 wherein N is greater than or equal to 2.

1 9. The method of claim 7, further comprising the step of calculating each of
2 said plurality of second averaged velocity datapoints $v_{(i)avg}$ using the equation:

3
$$V_{(i)avg} = (1/(2N+1))(V_{(i-2N)} + V_{(i-(2N-1))} + V_{(i-(2N-2))} \dots + V_{(i)}),$$

4 wherein N is greater than or equal to 2.

1 10. The method of claim 6, further comprising the steps of:

2 forming a first acceleration profile using said first velocity profile;

3 calculating said third velocity profile by passing said first acceleration profile

4 through a low pass nth order Butterworth filter having a cutoff frequency less than about

5 15 hertz, wherein n is greater than or equal to 3.

1 11. An article of manufacture comprising a computer useable medium having

2 computer readable program code disposed therein for moving an accessor from a first

3 location to a second location within a data storage and retrieval system, wherein said

4 accessor comprises a velocity control program, and wherein said accessor is capable of

5 traveling at a velocity V_{MAX} and accelerating at a maximum acceleration a_{MAX} , the

6 computer readable program code comprising a series of computer readable program steps

7 to effect:

8 receiving a request to move said accessor a distance from a first location to a

9 second location;

10 forming a first velocity profile wherein said accessor travels said distance in the

11 minimum time interval, and wherein said first velocity profile requires a first maximum

12 acceleration change;

13 calculating a second velocity profile, wherein said second velocity profile

14 includes a second maximum acceleration change, wherein said second maximum

15 acceleration change is less than said first maximum acceleration change;

16 determining if said accessor reaches a_{MAX} using said second velocity profile;

17 operative if said accessor does not reach a_{MAX} using said second velocity profile,
18 loading said first velocity profile into said velocity control program;
19 operative if said accessor does reach a_{MAX} using said first velocity profile, loading
20 said second velocity profile into said velocity control program;
21 moving said accessor using said velocity control program.

1 12. The article of manufacture of claim 11, the computer readable program
2 code comprising a series of computer readable program steps to effect:

3 calculating a plurality of first velocity datapoints $v_{(i)}$ based upon said distance,
4 said V_{MAX} , and said a_{MAX} , wherein said first velocity profile comprises said plurality of
5 first velocity datapoints;

6 averaging two or more of said first velocity datapoints $v_{(i)}$ to form each of a
7 plurality of first averaged velocity datapoints $v_{(i)avg}$;

8 forming said second velocity profile using said plurality of first averaged velocity
9 datapoints $v_{(i)avg}$.

1 13. The article of manufacture of claim 12, the computer readable program
2 code comprising a series of computer readable program steps to effect calculating each of
3 said plurality of first averaged velocity datapoints $v_{(i)avg}$ using the equation:

4
$$V_{(i)avg} = (1/(2N+1))(V_{(i-N)} + V_{(i-(N-1))} \dots + V_{(i)} \dots + V_{(i+(N-1))} + V_{(i+(N))}),$$

5 wherein N is greater than or equal to 1.

1 14. The article of manufacture of claim 12, the computer readable program
2 code comprising a series of computer readable program steps to effect calculating each of
3 said plurality of averaged velocity datapoints $v_{(i)avg}$ using the equation:

4
$$V_{(i)avg} = (1/(2N+1))(V_{(i-2N)} + V_{(i-2N-1))} + V_{(i-2N-2))} \dots + V_{(i)}),$$

5 wherein N is greater than or equal to 1.

1 15. The article of manufacture of claim 11, the computer readable program
2 code comprising a series of computer readable program steps to effect:

3 forming a first acceleration profile using said first velocity profile;

4 calculating said second velocity profile by passing said first acceleration profile
5 through a low pass Butterworth filter having a cutoff frequency greater than or equal to
6 about 15 hertz.

1 16. The article of manufacture of claim 11, the computer readable program
2 code comprising a series of computer readable program steps to effect:

3 receiving a request to transport an object;

4 setting a threshold moment arm for said accessor;

5 calculating an actual moment arm for said accessor carrying said object;

6 determining if said actual moment arm exceeds said threshold moment arm;

7 operative if said actual moment arm exceeds said threshold moment arm,

8 calculating a third velocity profile, wherein said third velocity profile includes a third
9 maximum acceleration change, wherein said third maximum acceleration change is less
10 than said second maximum acceleration change.

1 17. The article of manufacture of claim 16, the computer readable program
2 code comprising a series of computer readable program steps to effect:

3 calculating a plurality of first velocity datapoints $v_{(i)}$ based upon said distance,
4 said V_{MAX} , and said a_{MAX} , wherein said first velocity profile comprises said plurality of
5 first velocity datapoints;
6 averaging three or more of said first velocity datapoints $v_{(i)}$ to form each of a
7 plurality of second averaged velocity datapoints $v_{(i)avg}$;
8 forming said third velocity profile using said plurality of second averaged velocity
9 datapoints $v_{(i)avg}$.

1 18. The article of manufacture of claim 17, the computer readable program
2 code comprising a series of computer readable program steps to effect calculating each of
3 said plurality of second averaged velocity datapoints $v_{(i)avg}$ using the equation:

$$4 \quad V_{(i)avg} = (1/(2N+1))(V_{(i-N)} + V_{(i-(N-1))} \dots + V_{(i)} \dots + V_{(i+(N-1))} + V_{(i+(N))}),$$

5 wherein N is greater than or equal to 2.

1 19. The article of manufacture of claim 17, the computer readable program
2 code comprising a series of computer readable program steps to effect calculating each of
3 said plurality of second averaged velocity datapoints $v_{(i)avg}$ using the equation:

$$4 \quad V_{(i)avg} = (1/(2N+1))(V_{(i-2N)} + V_{(i-(2N-1))} + V_{(i-(2N-2))} \dots + V_{(i)}),$$

5 wherein N is greater than or equal to 2.

1 20. The article of manufacture of claim 16, the computer readable program
2 code comprising a series of computer readable program steps to effect:
3 forming a first acceleration profile using said first velocity profile;

4 calculating said third velocity profile by passing said first acceleration profile
5 through a low pass nth order Butterworth filter having a cutoff frequency less than about
6 15 hertz, wherein n is greater than or equal to 3

1 21. A computer program product usable with a programmable computer
2 processor having computer readable program code embodied therein for moving an
3 accessor from a first location to a second location within a data storage and retrieval
4 system, wherein said accessor is capable of traveling at a velocity V_{MAX} and accelerating
5 at a maximum acceleration a_{MAX} , comprising:

6 computer readable program code which causes said programmable computer
7 processor to receive a request to move said accessor a distance from a first location to a
8 second location;

9 computer readable program code which causes said programmable computer
10 processor to form a first velocity profile wherein said accessor travels said distance in the
11 minimum time interval, and wherein said first velocity profile requires a first maximum
12 acceleration change;

13 calculate a second velocity profile, wherein said second velocity profile includes a
14 second maximum acceleration change, wherein said second maximum acceleration
15 change is less than said first maximum acceleration change;

16 computer readable program code which causes said programmable computer
17 processor to determine if said accessor reaches a_{MAX} using said second velocity profile;

18 computer readable program code which, if said accessor does not reach a_{MAX}
19 using said second velocity profile, causes said programmable computer processor to load
20 said first velocity profile into said velocity control program;
21 computer readable program code which, if said accessor does reach a_{MAX} using
22 said second velocity profile, causes said programmable computer processor to load said
23 second velocity profile into said velocity control program; and
24 computer readable program code which causes said programmable computer
25 processor to move said accessor using said velocity control program.

1 22. The computer program product of claim 21, further comprising:

2 computer readable program code which causes said programmable computer
3 processor to calculate a plurality of first velocity datapoints $v_{(i)}$ based upon said distance,
4 said V_{MAX} , and said a_{MAX} ;
5 computer readable program code which causes said programmable computer
6 processor to average two or more of said first velocity datapoints $v_{(i)}$ to form each of a
7 plurality of first averaged velocity datapoints $v_{(i)avg}$;
8 computer readable program code which causes said programmable computer
9 processor to calculate said second velocity profile using said plurality of first averaged
10 velocity datapoints $v_{(i)avg}$.

1 23. The computer program product of claim 22, further comprising computer
2 readable program code which causes said programmable computer processor to calculate
3 each of said plurality of first averaged velocity datapoints $v_{(i)avg}$ using the equation:

4
$$V_{(i)avg} = (1/(2N+1))(V_{(i-N)} + V_{(i-(N-1))} \dots + V_{(i)} \dots + V_{(i+(N-1))} + V_{(i+N)}),$$

5 wherein N is greater than or equal to 1.

1 24. The computer program product of claim 22, further comprising computer
2 readable program code which causes said programmable computer processor to calculate
3 each of said plurality of averaged velocity datapoints $V_{(i)avg}$ using the equation:

4
$$V_{(i)avg} = (1/(2N+1))(V_{(i-2N)} + V_{(i-(2N-1))} + V_{(i-(2N-2))} \dots + V_{(i)}),$$

5 wherein N is greater than or equal to 1.

1 25. The computer program product of claim 21, further comprising:
2 computer readable program code which causes said programmable computer
3 processor to form a first acceleration profile using said first velocity profile; and
4 computer readable program code which causes said programmable computer
5 processor to calculate said second velocity profile by passing said first acceleration
6 profile through a low pass Butterworth filter having a cutoff frequency greater than or
7 equal to 15 hertz.

1 26. The computer program product of claim 21, further comprising:
2 computer readable program code which causes said programmable computer
3 processor to receive a request to transport an object;
4 computer readable program code which causes said programmable computer
5 processor to retrieve a predetermined threshold moment arm for said accessor;
6 computer readable program code which causes said programmable computer
7 processor to calculating an actual moment arm for said accessor carrying said object;
8 computer readable program code which causes said programmable computer
9 processor to determining if said actual moment arm exceeds said threshold moment arm;

10 computer readable program code which causes said programmable computer
11 processor to operative if said actual moment arm exceeds said threshold moment arm,
12 calculating a third velocity profile, wherein said third velocity profile includes a third
13 maximum acceleration change, wherein said third maximum acceleration change is less
14 than said second maximum acceleration change.

1 27. The computer program product of claim 26, further comprising:
2 computer readable program code which causes said programmable computer
3 processor to calculate a plurality of first velocity datapoints $v_{(i)}$ based upon said distance,
4 said V_{MAX} , and said a_{MAX} ;
5 computer readable program code which causes said programmable computer
6 processor to average three or more of said first velocity datapoints $v_{(i)}$ to form each of a
7 plurality of second averaged velocity datapoints $v_{(i)avg}$;
8 computer readable program code which causes said programmable computer
9 processor to form said third velocity profile using said plurality of second averaged
10 velocity datapoints $v_{(i)avg}$.

1 28. The computer program product of claim 27, further comprising computer
2 readable program code which causes said programmable computer processor to calculate
3 each of said plurality of second averaged velocity datapoints $v_{(i)avg}$ using the equation:
4
$$V_{(i)avg} = (1/(2N+1))(V_{(i-N)} + V_{(i-(N-1))} \dots + V_{(i)} \dots + V_{(i+(N-1))} + V_{(i+(N))},$$

5 wherein N is greater than or equal to 2.

1 29. The computer program product of claim 27, further comprising computer
2 readable program code which causes said programmable computer processor to calculate
3 each of said plurality of second averaged velocity datapoints $v_{(i)avg}$ using the equation:

4
$$V_{(i)avg} = (1/(2N+1))(V_{(i-2N)} + V_{(i-(2N-1))} + V_{(i-(2N-2))} \dots + V_{(i)}),$$

5 wherein N is greater than or equal to 2.

1 30. The computer program product of claim 6, further comprising:
2 computer readable program code which causes said programmable computer
3 processor to form a first acceleration profile using said first velocity profile; and
4 computer readable program code which causes said programmable computer
5 processor to form said third velocity profile by passing said first acceleration profile
6 through a low pass nth order Butterworth filter having a cutoff frequency less than about
7 15 hertz, wherein n is greater than 3.